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## (54) PUSHBUTTON SWITCH


(71) We, NORTHERN TELECOM LIMITED (formerly known as Northern Electric Company Limited), a Canadian company of 1600 Dorchester Blvd. West Montreal, Quebec, Canada, H3H 1R1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—


This invention relates to pushbutton switches, in particular to pushbutton switches as are used in keyboards for telephone dials, calculating machines, computer input terminal and similar applications.

Keyboards are in very wide use and a most important part of a keyboard is the key or pushbutton switch. Present keys, or pushbutton switches, have many disadvantages, such as high contact resistance, relatively short lift, contact bounce, are often bulky in relation to the installation or apparatus with which they are associated, and are subject to ingress of dirt and moisture.

While at least some of these disadvantages can be overcome by special design of the pushbutton switch, this adds to the complexity and cost, may make the switch more bulky and may have detrimental effect on the useful life of a switch.

The present invention provides a pushbutton switch, or key, which gives low contact resistance, is simple and economical to manufacture, can provide a sealed construction, has a long life and can be of a low profile. Other advantages will become apparent in the following description.

A pushbutton switch in accordance with the invention comprises an electrically insulating base member, an electrically conducting pattern attached to the base member and defining a switch area a spacer member having an aperture therein, the aperture being positioned over the switch area in the conducting pattern, an electrically conductive spring contact member on the spacer member having an aperture therein aligned with the aperture in the spacer member, at least one cantilevered resilient contact finger forming part of the spring contact member and located in the aperture in the contact member and extending inwardly from the periphery of the aperture in the contact member and having an inner extending toward the centre of the aperture in the contact member and an elastomeric member over the spring contact member; the elastomeric member being depressible over the aperture in the spacer member to depress the inner end of the, or each, contact finger through the aperture in the spacer member in a downward and outward movement into outward wiping contact with the conducting pattern while the outer end of the or each finger remains substantially undisplaced, the wiping motion being in a direction substantially parallel to that in which the or each finger extends.

The invention will be readily understood by the following description of certain embodiments, by way of example, in conjunction with the accompanying drawings, in which:—

Figure 1 is a plan view of part of a spring contact member illustrating one form of contact fingers;

Figure 2 is a cross-section on the line II—II of Figure 1;

Figure 3 is a cross-section through one form of switch, in accordance with the present invention, and also illustrating a modification thereof;

Figure 4 is a cross-section on the line IV—IV of Figure 3; illustrating a conductor pattern, for a multiple switch device;

Figure 5 is a cross-section, similar to that of Figure 3, illustrating another form of switch in accordance with the present invention;

Figure 6 is a perspective view of a spring contact plate having a plurality of switching positions therein;

Figure 7 is an exploded view of yet a further form of switch in accordance with the present invention; and

Figure 8 is a cross-section, similar to those of Figures 3 and 5, through the switch illustrated in Figure 7.

As stated previously, present pushbutton switches suffer from various disadvantages which switches in accordance with the present invention either avoid or substantially re-

duce. The basic feature of the present invention, providing the advantages of a simple, economic and effective switch, is the spring contact plate with the contact finger formation. Figures 1 and 2 illustrate a particular useful form of contact plate and contact finger arrangement. In Figure 1 part of a spring contact plate 10 is shown. Four contact fingers 11 are formed in the plate, extending radially inwardly of an aperture in the plate. A typical suitable material for the contact plate is beryllium copper sheet, approximately .003" thick. However, other materials can be used for example phosphor bronze. The fingers 11 can be formed by stamping, or chemical etching.

As will be seen more clearly in Figure 2, each contact finger 11 has two convolutions 12 formed therein, one near the junction of the finger with the main body of the plate 10, and the other in the end portion 13 of each finger. It will be seen that in the example illustrated in Figure 1 each finger has an outer portion 14 tapering inwardly from the junction — with the main body of the plate, and the end portion 13 which again tapers. At the junction of the end portion 13 with the outer portion 14, the end potrion is wider than the outer portion 14 and tapers inwardly. Each finger has an appearance somewhat like an arrow head. Such a form provides good flexibility with a wide contact area, the contact area being on the inner end portion 13. The contact finger form illustrated in Figures 1 and 2 are of one example form only. Other forms can be used. However the form shown does provide certain advantages, such as the aforementioned flexibility and wide contact area.

In use the spring contact plate 10 is mounted on a spacer 15 with an aperture therein aligned with the aperture in the contact plate. Thus the fingers will be deflected downward through the aperture in the spacer to contact one or more conductors.

Figure 3 illustrates one example of a switch, in accordance with the invention, and there is also illustrated a modification which can be embodied — as will be explained. As seen in Figure 3, a base or support member 20 carries a conductor pattern 21. A typical example of a conductor pattern is seen in Figure 4 — in this particular example the conductor pattern is for a pushbutton dial for a telephone. Typically the conductor pattern 21 can be a printed circuit carried by the support member 20.

Mounted on the base or support member 20 is the spacer 15, the spacer being in contact with the conductor pattern 21. The spacer is of insulating material or, if of conductive material is separated by a thin insulating layer from conductor pattern 21. On top of the spacer 15 is the spring contact plate 10. Over the spring contact plate 10 is positioned a combined cover plate and actuating member 22. The cover member 22 is of elastomeric material and has a boss 23 positioned over the contact fingers 11. A boss 23 is provided at each position of a switch and in a telephone dial, the conductor pattern of which is illustrated in Figure 4, for example, a pattern of bosses 23 is provided in the well known series of columns and rows. The positions of the bosses and the switch areas of the conducting patterns are indicated in Figure 4 by the dotted circles 24.

To close, or make, a switch, a boss 23 is pressed. This deflects the contact fingers 11 into contact with the conductor pattern 21. On release of pressure on the boss, the boss returns to its normal position and the contact fingers do the same.

In a modification a separate pushbutton 25 can be provided. The button 25 has a head portion 26 and a shank 27 which is positioned in a hole 28 formed in the cover 22. A flange 29 extending around the periphery of the head portion 26 encompasses the boss 23. The pushbutton 25 may be fixed relative to the cover 22 and pressure on the button will deflect the cover and thus the contact fingers 11, as previously described.

Figure 5 illustrates an alternative form of pushbutton. In the arrangement of Figure 5, the base or support member 20 carries the conductor pattern 21, as in Figure 3. Spacer 15 is also provided, on top of which the spring contact plate 10 is positioned. Thus far the assembly is as for the arrangement of Figure 3. Over the spring contact plate is placed an elastomeric sheet 30. Sheet 30 is of insulating material. A cover 31 is placed on the sheet 30, the cover having apertures 32 at positions coincident with the positions of the contact fingers 11. An upward extending flange or sleeve 33 surrounds each aperture 32. Positioned in each aperture is a plunger 34. A button 35 fits over the top of each flange or sleeve 33 and a compression spring 36 extends between the button 35 and the plunger 34. Plunger 34 deflects the sheet 30 and this in turn deflects the contact fingers into contact with the conductor pattern 21. The conductor pattern 21 can be of the same form as in the arrangement in Figure 3, that is as illustrated in Figure 4.

In switches of the types as illustrated in Figures 3 and 5, each switch position having a plurality of contact fingers, for example four, all the contact fingers are actuated together and generally all fingers act together and make one connection. Thus, for example, as seen in Figure 4, at any one position 24 there are two conductors and in close proximity. When a switch is actuated

two contact fingers are moved into contact with one of the conductors and two are moved into contact with the other of the conductors. As all the contact fingers are interconnected by being formed from a common sheet of material, an electrical connection is made between the two conductors. Figure 6 illustrates a typical form of a spring contact plate 10, as used for example for a pushbutton dial for a telephone in conjunction with a conductor pattern similar to that as illustrated in Figure 4. In Figure 6 only the two lowermost right-hand sets of contact fingers are fully shown and in practice the other ten sets are the same as those.

As stated, in the switches of the form illustrated in Figures 3 and 5, all contact fingers 11 are formed from a common sheet of electrically conductive material and each switch position normally makes a single connection. Even if more than one connection is made at a switch position obviously the circuits being connected are compatible in that they are at the same voltage, and no difficutlies will arise by them being connected at a common position.

However it is sometimes desired that more than one circuit be closed simultaneously but the circuits are not themselves compatible and cannot be closed by common switch members. An alternative form of switch, in accordance with the present invention is illustrated in Figures 7 and 8.

Figure 7 illustrates, in exploded view, the various layer components of a switch which is arranged to make three separate contact connections. In Figure 7 only the spring contact plates, interleaved insulating layers, the base member carrying the conductor patterns and a resilient top cover are shown. Taken in sequence, from the top in Figure 7 are the following:— elastomeric sheet or top cover 40; a first spring contact plate 41, having a single contact finger 42; first insulating layer 43; a second spring contact plate 44 with a single contact finger 45; a second insulating layer 46; a third spring contact plate 47 with a single contact finger 48; a spacer 49; and a conductor pattern comprising three circuits 50, 51 and 52 carried on a base or support member.

Each circuit has a switching or contacting portion 50*a*, 51*a* and 52*a* respectively comprising interleaved conductors. The portions 50*a*, 51*a* and 52*a* are, in the example illustrated, spaced at 120°, and similarly the separate contact fingers 42, 45 and 48 are spaced at 120° to align with the contacting portions 50*a*, 51*a* and 52*a* respectively. As will be seen apertures are formed in the insulating layers 43 and 46 and also the spacer 49 to permit the contact fingers 42, 45 and 48 to be deflected into with the circuits 50, 51 and 52. Contact of the fingers with the contact portions of the circuits at their contacting portions connects the interleavered conductors at each portion. Thus three separate circuits are closed or switched at the same time.

Figure 8 shows the various layer components assembled, together with the pushbutton. The pushbutton is similar to that illustrated in Figure 5, having a cover 31, aperture 32, upwardly extending flange 33, plunger 34, button 35 and compression spring 36. Operation of the switch of Figures 7 and 8 is the same as for the switch of Figure 5 — button 35 is depressed, compressing the spring 36. The plunger 34 is pushed downwards flexing the sheet 40 (30 in Figure 5) which in turn flexes the contact fingers 42, 45 and 48 (11 in Figure 5) into contact with the conductor pattern on the base or support member. Release of the button permits the contact fingers to return to their normal position.

The spring contact plates and insulating layers are shown increased in thickness, particularly in Figure 8, for the sake of clarity. A thickness of .003", using beryllium copper, has been found acceptable for the spring contact plates, and the insulating layers can be very thin also, for example .001" thick. The insulating layers can be formed directly on the spring contact plates, being varnish or some other suitable insulating material. As the spring contact plates and interleaved insulating layers are so thin, the stacking of a plurality of such plates does not restrict the operation of the switch to any undesirable degree.

The invention provides a very simple, economic and efficient switch. A completely sealed construction can be obtained and consistant operation provided. The contact fingers 11 can be varied in shape, but the shape illustrated — somewhat in the form of a arrow head — has been found to give excellent results. A wide contact area is provided while at the same time the fingers are very flexible. On initial blending, or flexing, contact is made with the conductor pattern and then as slight additional pressure is imposed to further bend, or flex, the fingers, the contact area on the fingers moves radially to give an outward wiping action substantially parallel to the direction of the respective finger. Thus consistent low resistance contacts are made. The life of switches in accordance with the invention have been very long, the stresses imposed on the moving parts being quite low. Contact bounce is eliminated, or at worst reduced to an extent which can be ignored. The size of a single switch, of a multiplicity of switches, is extremely small and a very compact switch is provided.

WHAT WE CLAIM IS:—

1. A pushbutton switch comprising; an electrically insulating base member, an elec-

trically conducting pattern attached to the base member and defining a switch area, a spacer member having an aperture therein, the aperture being positioned over the switch area in the conducting pattern, an electrically conductive spring contact member on the spacer member having an aperture therein aligned with the aperture in the spacer member, at least one cantilevered resilient contact finger forming part of the spring contact member and located in the aperture in the contact member and extending inwardly from the periphery of the aperture in the contact member and having an inner end extending toward the centre of the aperture in the contact member and an elastomeric member over the spring contact member; the elastomeric member being depressible over the aperture in the spacer member to depress the inner end of the, or each, contact finger through the aperture in the spacer member in a downward and outward movement into outward wiping contact with the conducting pattern while the outer end of the or each finger remains substantially undisplaced, the wiping motion being in a direction substantially parallel to that in which the or each finger extends.

2. A switch as claimed in claim 1, the electrically conducting pattern comprising a plurality of electric circuits and a switch area for each circuit, the spacer member having an aperture positioned over each switch area, the spring contact member having an aperture aligned with each aperture in the spacer member, and at least one cantilevered resilient contact finger in each aperture in the spring contact member, the elastomeric member extending over the spring contact member for depression over each aperture in the spacer member.

3. A switch as claimed in claim 1 or 2, the elastomeric member being in contact with the spring contact member.

4. A switch as claimed in claim 1, 2 or 3, including a plurality of such contact fingers in the or each aperture in the contact member.

5. A switch as claimed in any one of the preecding claims, comprising a pushbutton mounted on the elastomeric member and aligned with the or each switch area for depressing the elastomeric member.

6. A switch as claimed in claim 5, including a cover member over the elastomeric member, the pushbutton or pushbuttons being mounted in the cover member and adapted ot deflect the elastomeric member.

7. A switch as claimed in claim 1, comprising a plurality of electrically conductive spring contact members in superposed array, an insulating layer between each adjacent pair of contact members, the apertures in the contact members being in coaxial alignment and aligned with the aperture in the spacer member, and a cantilevered resilient contact finger in the aperture in each spring contact member, the contact fingers being spaced circumferentially relative to one another, whereby depression of the elastomeric member will deflect each finger into contact with the conducting pattern.

8. A switch substantially as described herein and as illustrated in Figures 1, 2 and 3 of the accompanying drawings.

9. A switch substantially as described herein and as illustrated in Figure 5 of the accompanying drawings.

10. A switch substantially as described herein in conjunction with Figures 1, 2, 3, 4 and 6 of the accompanying drawings.

11. A switch substantially as described herein and as illustrated in Figures 7 and 8 of the accompanying drawings.

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1484634 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

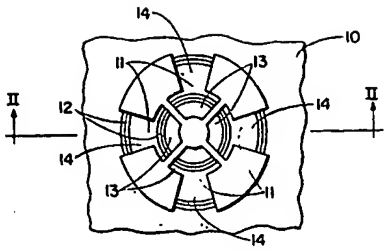


Fig. 1

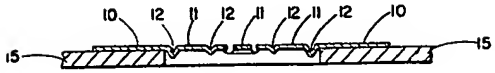


Fig. 2

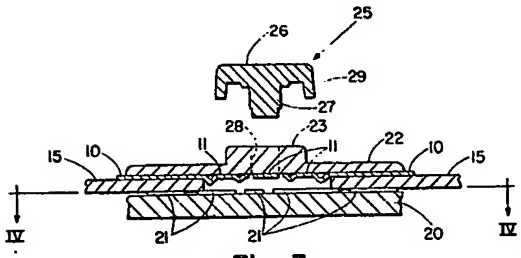


Fig. 3

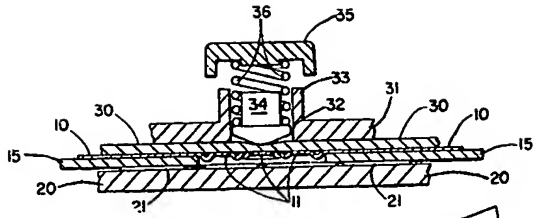


Fig. 5

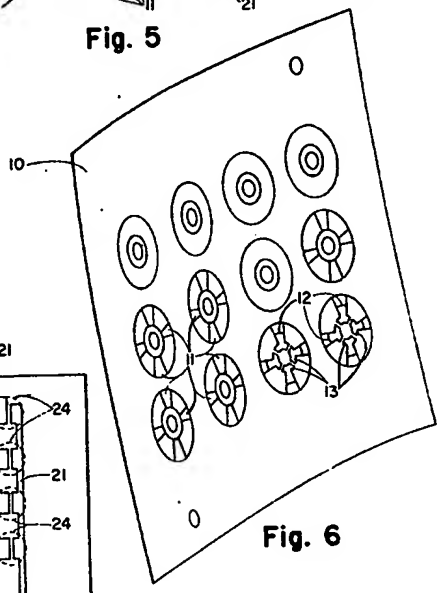


Fig. 6

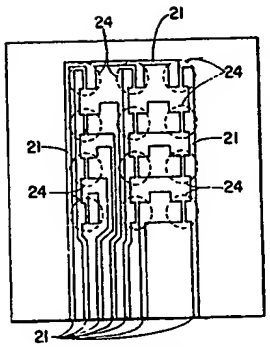


Fig. 4

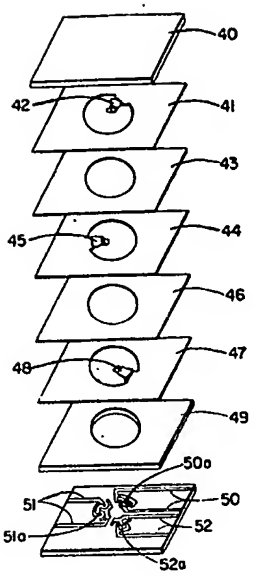
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Fig. 7

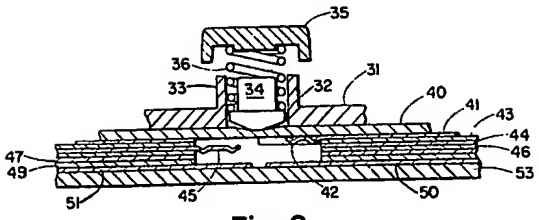
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Fig. 8